MISCELLANEOUS

MEMORANDUMS.

1796.

To find the cycle of the sun, or the number of it, for any year, you must add 9 to the year of Christ, and divide the sum by 28; the remainder is the number of the cycle. If 0 remain, take 28.

This cycle is a period of 28 years, in which time it shews all the variations of the dominical letter, which being ended, all the numbers and correspondent letters, return in the same order, for ever, by the Julian account; but only till the century is out, by the Gregorian. Its principal use is to find the Sunday letter, and it is also an ingredient in the Julian period.

To find the dominical letter for the *old style*, you must seek the number of the solar cycle, in the table below, and against it is the dominical letter. In the Julian account the additional number is perpetually 9, because it was 9 at the beginning of the Christian era; and as the whole contrivance was abitrary, the first year of the cycle was made a leap year, and set to the letters GF; the 2d is E; the 3d D; the 4th C; the 5th BA being leap again; and so on till it comes to 28, when it begins again.

For the *new style*, add 17 to the year of our Lord, and divide the sum by 28; the remainder being found in the table below, shews the dominical letter till 1800. If 0 remains, take 28. To make this rule general for the new style; instead of 17, between the beginning of 1800 and 1900, add 5; between 1900 and 2100, add 21; from 2100 to 2200, add 9, &c. and in general add 16 more at every hundred years forward, except such as are divisible by 4. But after 7 additions of 16, the same numbers will return again; that is, after 800 years. For $7 \times 16 = 4 \times 28$; therefore the numbers to be added, in these several periods of time, will be 17, 5, 21, 9, 25, 13, 1. Then 17, 5, &c. over again.

1 GF	5 BA	9 DC	13 FE	17 AG	21 CB	25 ED
2 E	6 G	10 B	14 D	18 F	22 A	26 C
3 D	7 F	11 A	15 C	19 E	23 G	27 B
4 C	8 E	12 G	16 B	20 D	24 F	28 A

By this table, the dominical letters for the year 1796 will be found as follows:

1796
17
28)1813(64
168
133
112
21=CB

But for the old style, 13 (the number of the cycle) stands against FE. In leap years there are two letters; one holds till the end of February; the other to the year's end.

TABLE of the dominical letters for each year, from the birth of Christ to the year 1600, according to the Julian Calendar.

				0 700 1400	100 800 1500	200 900	300 1000	400 1100	500 1200	600 1300
0	28	56	84	D C	E D	F E	G F	A G	B A	C B
1	29	57	85	B	C	D	E	F	G	A
2	30	58	86	A	B	C	D	E	F	G
3	31	59	87	G	A	B	C	D	E	F
4	32	60	88	F E	G F	A G	B A	C B	D C	E D
5	33	61	89	D	E	F	G	A	B	C
6	34	62	90	C	D	E	F	G	A	B
7	35	63	91	B	C	D	E	F	G	A
8	36	64	92	A G	B A	C B	D C	E D	F E	G F
9	37	65	93	F	G	A	B	C	D	E
10	38	66	94	E	F	G	A	B	C	D
11	39	67	95	D	E	F	G	A	B	C
12	40	68	96	C B	D C	E D	F E	G F	A G	B A
13	41	69	97	A	B	C	D	E	F	G
14	42	70	98	G	A	B	C	D	E	F
15	43	71	99	F	G	A	B	C	D	E
16	44	72		E D	F E	G F	A G	B A	C B	D C
17	45	73		C	D	E	F	G	A	B
18	46	74		B	C	D	E	F	G	A
19	47	75		A	B	C	D	E	F	G
20	48	76		G F	A G	B A	C B	D C	E D	F E
21	49	77		E	F	G	A	B	C	D
22	50	78		D	E	F	G	A	B	C
23	51	79		C	D	E	F	G	A	B
24	52	80		B A	C B	D C	E D	F E	G F	A G
25	53	81		G	A	B	C	D	E	F
26	54	82		F	G	A	B	C	D	E
27	55	83		E	F	G	A	B	C	D

The year 1582 had two dominical letters, G for the old calendar and C for the new one.

TABLE of the dominical letters for each year, from the birth of our Saviour to the year 1700, according to the Gregorian Calendar.

				0	100	200	300	400	500	600
				700	800	900	1000	1100	1200	1300
				1400	1500	1600				
0	28	56	84	G F	A G	B A	C B	D C	E D	F E
1	29	57	85	E	F	G	A	B	C	D
2	30	58	86	D	E	F	G	A	B	C
3	31	59	87	C	D	E	F	G	A	B
4	32	60	88	B A	C B	D C	E D	F E	G F	A G
5	33	61	89	G	A	B	C	D	E	F
6	34	62	90	F	G	A	B	C	D	E
7	35	63	91	E	F	G	A	B	C	D
8	36	64	92	D C	E D	F E	G F	A G	B A	C B
9	37	65	93	B	C	D	E	F	G	A
10	38	66	94	A	B	C	D	E	F	G
11	39	67	95	G	A	B	C	D	E	F
12	40	68	96	F E	G F	A G	B A	C B	D C	E D
13	41	69	97	D	E	F	G	A	B	C
14	42	70	98	C	D	E	F	G	A	B
15	43	71	99	B	C	D	E	F	G	A
16	44	72		A G	B A	C B	D C	E D	F E	G F
17	45	73		F	G	A	B	C	D	E
18	46	74		E	F	G	A	B	C	D
19	47	75		D	E	F	G	A	B	C
20	48	76		C B	D C	E D	F E	G F	A G	B A
21	49	77		A	B	C	D	E	F	G
22	50	78		G	A	B	C	D	E	F
23	51	79		F	G	A	B	C	D	E
24	52	80		E D	F E	G F	A G	B A	C B	D C
25	53	81		C	D	E	F	G	A	B
26	54	82		B	C	D	E	F	G	A
27	55	83		A	B	C	D	E	F	G

Continuation of the Table of the dominical letters to the year 2800.

				1600 2000 2400	1700 2100 2500	1800 2200 2600	1900 2300 2700
0	28	56	84	B A	C	E	G
1	29	57	85	G	B	D	F
2	30	58	86	F	A	C	E
3	31	59	87	E	G	B	D
4	32	60	88	D C	F E	A G	C B
5	33	61	89	B	D	F	A
6	34	62	90	A	C	E	G
7	35	63	91	G	B	D	F
8	36	64	92	F E	A G	C B	E D
9	37	65	93	D	F	A	C
10	38	66	94	C	E	G	B
11	39	67	95	B	D	F	A
12	40	68	96	A G	C B	E D	G F
13	41	69	97	F	A	C	E
14	42	70	98	E	G	B	D
15	43	71	99	D	F	A	C
16	44	72		C B	E D	F G	B A
17	45	73		A	C	E	G
18	46	74		G	B	D	F
19	47	75		F	A	C	E
20	48	76		E D	G F	B A	D C
21	49	77		C	E	G	B
22	50	78		B	D	F	A
23	51	79		A	C	E	G
24	52	80		G F	B A	D C	F E
25	53	81		E	G	B	D
26	54	82		D	F	A	C
27	55	83		C	E	G	B

TABLE for finding the day of the month, which answers to the day of the week, knowing the dominical letter for the year.

July April	Sept. Dec.	June	Feb. March Nov.	Aug.	May.	Jan. Oct.
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				
G	F	E	D	C	B	A
Sund.	Mond.	Tuesd.	Wed.	Thurs.	Frid.	Sat.

Days elapsed since the beginning of the year.				Add 1 in leap year after February.
Months.	First.	Tenth.	Twentieth.	
January	1	10	20	
February	32	41	51	
March	60	69	79	
April	91	100	110	
May	121	130	140	
June	152	161	171	
July	182	191	201	
August	213	222	232	
September	244	253	263	
October	274	283	293	
November	305	314	324	
December	335	344	354	

To find on what day of the week any day of the month may fall: for example, the 20th of May 1795, to 1796 complete, add the number of leap years therein contained, viz. 448; subtract 12 days for the new style, and 1 for the old style, and then add the number of days elapsed since the beginning of the year, viz. 140. The sum 2372, (1 being added for leap year) being divided by 7, there remains 6, which shews it to be Friday; if nothing remained, it would have been Saturday; if 1 had remained, it would have been Sunday, &c.

TABLE for finding on what day of the week the first day of each month falls upon, knowing the dominical letter of the year.

	A	B	C	D	E	F	G
Jan.	Sund.	Sat.	Frid.	Thur.	Wed.	Tues.	Mon.
Feb.	Wed.	Tues.	Mon.	Sund.	Sat.	Frid.	Thur.
Mar.	Wed.	Tues.	Mon.	Sund.	Sat.	Frid.	Thur.
April.	Sat.	Frid.	Thur.	Wed.	Tues.	Mon.	Sund.
May.	Mon.	Sund.	Sat.	Frid.	Thur.	Wed.	Tues.
June.	Thur.	Wed.	Tues.	Mon.	Sund.	Sat.	Frid.
July.	Sat.	Frid.	Thur.	Wed.	Tues.	Mon.	Sund.
Aug.	Tues.	Mond.	Sund.	Sat.	Frid.	Thur.	Wed.
Sept.	Frid.	Thur.	Wed.	Tues.	Mon.	Sund.	Sat.
Oct.	Sund.	Sat.	Frid.	Thur.	Wed.	Tues.	Mon.
Nov.	Wed.	Tues.	Mon.	Sund.	Sat.	Frid.	Thur.
Dec.	Frid.	Thur.	Wed.	Tues.	Mon.	Sund.	Sat.

Table for finding on what day of the month any day of the week falls upon, knowing what day of the week the first day of the month falls upon, by the last table.

SUNDAY.		MONDAY.	
Sund.	1. 8.15.22 29	Mon.	1. 8.15.22.29.
Mond.	2. 9.16 23.30.	Tues.	2 9.16.23.30.
Tues.	3.10.17.24.31	Wed.	3.10.17 24.31.
Wed.	4.11.18 25.	Thur.	4.11.18.25.
Thur.	5.12.19.26.	Frid.	5.12.19.26.
Frid.	6.13.20.27.	Sat.	6.13.20.27
Sat.	7.14.21.28.	Sund	7.14 21.28.

TUESDAY.		WEDNESDAY.	
Tues.	1. 8.15.22.29.	Wed.	1. 8.15.22.29
Wed.	2. 9.16.23.30.	Thur.	2. 9.16.23.30
Thur.	3.10.17 24.31.	Frid.	3.10.17 24.31
Frid.	4.11.18.25.	Sat.	4.11.18 25.
Sat.	5.12.19.26.	Sund.	5.12.19.26.
Sund.	6.13.20.27.	Mon.	6.13.20.27.
Mon.	7.14.21.28.	Tues.	7.14.21.28.

THURSDAY.	
Thur.	1. 8.15.22.29
Frid.	2. 9.16 23.30.
Sat.	3.10.17.24.31.
Sund.	4.11.18.25.
Mon.	5.12.19.26.
Tues.	6.13.20.27.
Wed.	7.14.21.28.

FRIDAY.	
Frid.	1. 8.15.22.29.
Sat.	2. 9.16.23.30.
Sund.	3.10.17.24.31.
Mon.	4.11.18.25.
Tues.	5.12.19.26.
Wed.	6.13.20.27.
Thur.	7.14.21.28.

7 SATURDAY.	
Sat.	1. 8.15 22.29.
Sund.	2. 9 16.23.29.
Mon.	3.10.17.24.31.
Tues.	4.11.18.25.
Wed.	5.12.19.26.
Thur.	6.13.20.27.
Frid.	7.14.21.28.

By these two tables, the day of the week on which any day of the month falls, in any year, from the birth of Christ, may be found, knowing the dominical letter of the year. For example, the battle of Towton was fought on the 29th of March, 1461. D was the dominical letter of that year; hence the first day of March was on a Sunday in that year; and looking for 29 in the preceding table, under Sunday, written in capital letters, I find the 29th of March was on a Sunday.

The *golden number*, or cycle of the moon, is a period of 19 years, which being ended, the new moons and full moons fall on the same day of the month, as they did 19 years before. To find it, divide the year of our Lord by 19, and to the remainder add 1, for both old and new style.

The new moons fall on the same days and the same months, in years which have the same golden number.

The *epact* is the number to be added to the lunar year to make it equal to the solar. Its use is for finding the new moons in March, and from thence in every other month. To find it, take 1 from the golden number, and then multiply the remainder by 11, and divide the product by 30, and the remainder is the epact for the *new style*: when o remains, take 29. This rule holds from 1700 to 1900, after which the epact so found must be lessened by 1; and for every 240 years after, it must be lessened by 1 more, continually.

For the *old style*, multiply the golden number by 11, and divide by 30, for all years: therefore, having the epact for

the old style, that for the new style may be found by subtracting 11 from the old one.

Seek the golden number for the year in the following table of epacts, and against it is the epact sought. This table continues in force from 1700 to 1900; after which the epact must be lessened by 1.

Golden N.	Epact.
1	29
2	11
3	22
4	3
5	14
6	25
7	6
8	17
9	28
10	9
11	20
12	1
13	12
14	23
15	4
16	15
17	26
18	7
19	18

To find the day of the moon's changing in March, add 1 to the epact, and subtract the sum from 30, the remainder is the day of the change; hence to find the moon's age on any given day in the year, you must add to the epact the number of months from March inclusively, and subtract the sum from 30 or from 60, and the remainder will shew the new moon of the month in question; which being taken from the number of days, will shew the moon's age: or otherwise, add together the epact, the number of months from March, inclusively, and the day of the month, the sum will be the moon's age for that day, if it be not greater than 30; in that case take 30 from it, and the remainder will be the age of the moon.

As the epacts only begin in March, if the moon's age be wanted in the months that precede March, the epact of the year before must be made use of.

The Indiction was a period of fifteen years, of use among the Romans; but is now of no use, only as an ingredient in the Julian period. To find it, add 3 to the year of Christ, and divide it by 15, the remainder is the indiction: if o remains, it is 15.

By a continual multiplication of these three cycles, the Golden number 19, the Solar cycle 28, and the Indiction 15, the Julian period is produced, first introduced into chronological computations by Julius Scaliger. The number 7980 contains all the different combinations of the three cycles, so as only to be placed once in the same order in all that time. The beginning of this period is 4714 years before Christ; so that if the number of this period be wanted for any year, you must add 4713 to the number of the proposed year, and the sum will be the year of the Julian period.

To find the day of Easter full moon, which is the first full moon after the 21st of March for the *new style*, subtract the epact for the year from 44; and if the remainder be equal or greater than 21, it is the day of full moon; if less, add 30 to it, and it gives Easter limit.

For the *old style*, subtract the old epact from 47.

Easter day is the first Sunday after the Pascal full moon. It can never fall sooner than March 22, nor later than April 25. The distance of Easter Sunday from March 21, is sometimes called the number of *direction*.

To find Easter day in any given year, seek the golden number in the first column of the following table; against which, in the 2d column, stands the day of Easter full moon. Then look in the 3d column for the Sunday letter next following, and the day of the month standing against it in the 2d column is Easter day. This holds from 1700 till 1900, *new style*. If the full moon happens on a Sunday, the next Sunday is Easter day. In leap years, take the letter for the end of the year. For example, to find Easter day in 1797; the golden number is 12, and Sunday letter A; against 12, in the following table, stands April 12 and D; and looking down to A, it stands against April 16th, which is Easter day.

Golden Numb.	Months, Days.	Sund. letter.
14	Mar. 21	C
3	22	D
—	—— 23	E
11	24	F
—	25	G
19	26	A
8	27	B
—	—— 28	C
16	29	D
5	30	E
—	—— 31	F
13	Apr. 1	G
2	2	A
—	—— 3	B
10	4	C
—	—— 5	D
18	6	E
7	7	F
—	—— 8	G
15	9	A
4	10	B
—	—— 11	C
12	12	D
1	13	E
—	—— 14	F
9	15	G
—	—— 16	A
17	17	B
6	18	C
	19	D
	20	E
	21	F
	22	G
	23	A
	24	B
	25	C

Easter regulates the times of all the moveable feasts; hence they may be easily known. Septuagesima Sunday is 9 weeks before Easter, or the 64th day, including Easter day. Ash Wednesday is the 47th day before Easter, reckoning both days. Ascension day is 40 days after Easter. Rogation days begin on the Monday before the Ascension. Whitsunday is 50 days after Easter. Trinity Sunday is 57 days after Easter. Advent Sunday must fall upon the Sunday between the 27th of November and the 3d of December, both days inclusive. Ember days are kept four times in the year. 1st. They begin on the Wednesday in the first week in lent. 2d. On the Wednesday in Whitsun week. 3d. On the Wednesday after the 14th of September. 4th. On the Wednesday after the 13th of December.

The era of the Olympiads begins in the year 3938 of the Julian period; 775 years before Christ, the solar cycle was 18; the lunar cycle 5, and the indiction 8.

The foundation of Rome answers to the year 3961 of the Julian period; 752 years before Christ; solar cycle 13, lunar cycle 9, indiction 1.

The era of Nabonassar begins in the year 3967 of the Julian period; 746 before Christ; solar cycle 19, lunar cycle 15, indiction 7.

The death of Alexander the Great happened in the year 4390 of the Julian period, 323 years before Christ.

The epocha of the Turks, or the Hegira, begins in the year 5335 of the Julian period, 622 years after Christ.

The Thermometers most in use at present are those of Fahrenheit, Reaumur, and Celsius. In Fahrenheit's scale, the number of divisions between the freezing and boiling water point is 180; the freezing point being at 32, and the boiling point at 212, both above 0, or the part from which the divisions are reckoned both ways. In Reaumur's scale the interval is 80, and the freezing point is called 0; from which the divisions are reckoned both ways. In the thermometer of Celsius, the interval is divided into 100 parts, and the freezing point is called 0, as in that of Reaumur. To reduce these scales to each other, it must be observed, that one division of Fahrenheit's is equal to $\frac{4}{9}$ of a division of Reaumur, and to $\frac{5}{9}$ of a division of Celsius: therefore if the number of divisions of Fahrenheit, reckoned above or below the freezing point, be multiplied by 4, and divided by 9, the the quotient will be the corresponding number in Reaumur's scale; or if the multiplier 5 and the divisor 9 be used, the quotient will give the divisions of Celsius's scale: and, contrariwise, if any number of divisions, either of Reaumur's or Celsius, be multiplied by 9, and divided by 4, if of Reaumur, or by 5 if of Celsius, the quotient will give the divisions of Fahrenheit, reckoned either above or below the freezing point, as the case may be. See the following Tables.

TABLE of the Correspondence of the Thermometers of Celsius, Reaumur, and Fahrenheit.

Celsius.	Reaum.	Fahr.	Celsius.	Reaum.	Fahr.
100	80.	212.	89	71.2	192.2
99	79.2	210.2	88	70.4	190 4
98	78.4	208.4	87	69.6	188.6
97	77.6	206.6	86	68.8	186 8
96	76.8	204.8	85	68.	185.
95	76.	203.	84	67.2	183.2
94	75.2	201,2	83	66 4	181.4
93	74.4	199.4	82	65.6	179.6
92	73.6	197.6	81	64.8	177 8
91	72.8	195.8	80	64.	176.
90	72.	194.	79	63.2	174.2

TABLE of the Correspondence of the Thermometers of Celsius, Reaumur, and Fahrenheit.

Celsius.	Reaum.	Fahr.	Celsius.	Reaum.	Fahr.
78	62.4	172.4	38	30.4	100.4
77	61.6	170.6	37	29.6	98.6
76	60.8	168.8	36	28.8	96.8
75	60.	167.	35	28.	95.
74	59.2	165 2	34	27.2	93.2
73	58.4	163.4	33	26.4	91.4
72	57.6	161.6	32	25.6	89.6
71	56.8	159.8	31	24.8	87.8
70	56.	158.	30	24.	86.
69	55.2	156.2	29	23.2	84.2
68	54.4	154.4	28	22.4	82.4
67	53.6	152.6	27	21.6	80.6
66	52.8	150.8	26	20.8	78.8
65	52.	149.	25	20.	77.
64	51.2	147.2	24	19 2	75.2
63	50.4	145.4	23	18.4	73.4
62	49.6	143.6	22	17.6	71.6
61	48.8	141.8	21	16.8	69.8
60	48.	140.	20	16.	68.
59	47.2	138.2	19	15.2	66.2
58	46.4	136.4	18	14.4	64.4
57	45.6	134.6	17	13.6	62.6
56	44.8	132.8	16	12.8	60.8
55	44.	131.	15	12.	59.
54	43.2	129.2	14	11 2	57.2
53	42.4	127.4	13	10 4	55.4
52	41.6	125.6	12	9 6	53.6
51	40.8	123.8	11	8.8	51.8
50	40.	122.	10	8.	50.
49	39 2	120.2	9	7.2	48.2
48	38 4	118.4	8	6 4	46.4
47	37.6	116.6	7	5.6	44.6
46	36.8	114.8	6	4 8	42.8
45	36.	113.	5	4.	41.
44	35.2	111.2	4	3.2	39.2
43	34.4	109.4	3	2.4	37.4
42	33.6	107.6	2	1.6	35.6
41	32.8	105.8	1	0.8	33.8
40	32.	104.	0	0.	32.
39	31.2	102.2			

TABLE of the Correspondence of the Thermometers of Reaumur, Fahrenheit, and Celsius.

Reaum.	Fahr.	Celsius.	Reaum.	Fahr.	Celsius.
80	212.	100.	39	119.75	48.75
79	209.75	98.75	38	117.5	47.5
78	207.5	97.5	37	115.25	46.25
77	205.25	96.25	36	113.	45.
76	203.	95.	35	110.75	43.75
75	200.75	93.75	34	108.5	42.5
74	198.5	92.5	33	106.25	41.25
73	196.25	91.25	32	104.	40.
72	194.	90.	31	101.75	38.75
71	191.75	88.75	30	99.5	37.5
70	189.5	87.5	29	97.25	36,25
69	187.25	86.25	28	95.	35.
68	185.	85.	27	92 75	33.75
67	182.75	83.75	26	90.5	32.5
66	180.5	82.5	25	88.25	31.25
65	178.25	81.25	24	86.	30.
64	176.	80.	23	83.75	28.75
63	173.75	78.75	22	81.5	27.5
62	171.5	77.5	21	79.25	26.25
61	169.25	76.25	20	77.	25.
60	167.	75.	19	74.75	23,75
59	164.75	73.75	18	72.5	22.5
58	162.5	72.5	17	70.25	21.25
57	160.25	71.25	16	68.	20.
56	158.	70.	15	65.75	18.75
55	155.75	68.75	14	63.5	17.5
54	153.5	67.5	13	61.25	16.25
53	151.25	66.25	12	59.	15.
52	149.	65.	11	56.75	13.75
41	146.75	63.75	10	54.5	12.5
50	144.5	62.5	9	52.25	11.25
49	142.25	61.25	8	50.	10.
48	140.	60.	7	47.75	8.75
47	137.75	58.75	6	45.5	7.5
46	135.5	57.5	5	43.25	6.25
45	133.25	56,25	4	41.	5.
44	131.	55.	3	38.75	3.75
43	128.75	53.75	2	36.5	2.5
42	126.5	52.5	1	34.25	1.25
41	124.25	51.25	0	32.	0.
40	122.	50.			

TABLE of the Correspondence of the Thermometers of Fahrenheit, Reaumur, and Celsius.

Fahr.	Reaum.	Celsius.	Fahr.	Reaum.	Celsius.
212	80.0	100.	171	61.7	77.2
211	79.5	99.4	170	61.3	76.6
210	79.1	98.8	169	60.8	76.1
209	78.6	98.3	168	60.4	75.5
208	78.2	97.7	167	60.0	75.
207	77.7	97.2	166	59.5	74.4
206	77.3	96.6	165	59.1	73.8
205	76.8	96.1	164	58.6	73.3
204	76.4	95.5	163	58.2	72.7
203	76.0	95.	162	57.7	72.2
202	75.5	94.4	161	57.3	71.6
201	75.1	93.8	160	56.8	71.1
200	74.6	93.3	159	56.4	70.5
199	74.2	92.7	158	56.	70.
198	73.7	92.2	157	55.5	69.4
197	73.3	91.6	156	55.1	68.8
196	72.8	91.1	155	54.6	68.3
195	72.4	90.5	154	54.2	67.7
194	72.	90.	153	53.7	67.2
193	71.5	89.4	152	53.3	66.6
192	71.1	88.8	151	52.8	66.1
191	70.6	88.3	150	52.4	65.5
190	70.2	87.7	149	52.	65.
189	69.7	87.2	148	51.5	64.4
188	69.3	86.6	147	51.1	63.8
187	68.8	86.1	146	50.6	63.3
186	68.4	85.5	145	50.2	62.7
185	68.0	85.	144	49.7	62.2
184	67.5	84.4	143	49.3	61.6
183	67.1	83.8	142	48.8	61.1
182	66.6	83.3	141	48.4	60.5
181	66.2	82.7	140	48.	60.
180	65.7	82.2	139	47.5	59.4
179	65.3	81.6	138	47.1	58.8
178	64.8	81.1	137	46.6	58.3
177	64.4	80.5	136	46.2	57.7
176	64.0	80.0	135	45.7	57.2
175	63.5	79.4	134	45.3	56.6
174	63.1	78.8	133	44.8	56.1
173	62.6	78.3	132	44.4	55.5
172	62.2	77.7	131	44.	55.

TABLE of the Correspondence of the Thermometers of Fahrenheit, Reaumur, and Celsius.

Fahr.	Reaum.	Celsius.	Fahr.	Reaum.	Celsius.
130	43.5	54.4	89	25.3	31.6
129	43 1	53.8	88	24.8	31.1
128	42.6	53.3	87	24.4	30.5
127	42.2	52.7	86	24.	30.
126	41.7	52.2	85	23.5	29.4
125	41.3	51.6	84	23.1	28.8
124	40.8	51.1	83	22.6	28.3
123	40.4	50.5	82	22.2	27.7
122	40.	50.	81	21.7	27.2
121	39.5	49.4	80	21.3	26.6
120	39.1	48.8	79	20.8	26.1
119	38.6	48.3	78	20.4	25.5
118	38.2	47.7	77	20.	25.
117	37.7	47 2	76	19.5	24.4
116	37.3	46.6	75	19.1	23.8
115	36.8	46.1	74	18.6	23.3
114	36.4	45.5	73	18.2	22.7
113	36.	45.	72	17.7	22.2
112	35.5	44.4	71	17.3	21.6
111	35.1	43.8	70	16.8	21.1
110	34.6	43.3	69	16.4	20.5
109	34.2	42 7	68	16.	20.
108	33.7	42.2	67	15.5	19.4
107	33.3	41.6	66	15.1	18.8
106	32.8	41.1	65	14.6	18.3
105	32.4	40.5	64	14.2	17.7
104	32.	40.	63	13.7	17.2
103	31.5	39 4	62	13.3	16.6
102	31.1	38.8	61	12.8	16.1
101	30.6	38.3	60	12.4	15.5
100	30.2	37.7	59	12.	15.
99	29.7	37.2	58	11.5	14.4
98	29.3	36.6	57	11.1	13.8
97	28.8	36.1	56	10.6	13.3
96	28.4	35.5	55	10.2	12.7
95	28.	35.	54	9.7	12.2
94	27.5	34.4	53	9.3	11.6
93	27.1	33.8	52	8.8	11.1
92	26.6	33.3	51	8.4	10.5
91	26.2	32.7	50	8.	10.
90	25.7	32.2	49	7.5	9.4

TABLE of the Correspondence of the Thermometers of Fahrenheit, Reaumur, and Celsius.

Fahr.	Reaum.	Celsius.	Fahr.	Reaum.	Celsius.
48	7.1	8.8	24	3.5	4.4
47	6.6	8.3	23	4.	5.
46	6.2	7.7	22	4.4	5.5
45	5.7	7.2	21	4.8	6.1
44	5.3	6.6	20	5.3	6.6
43	4.8	6.1	19	5.7	7.2
42	4.4	5.5	18	6.2	7.7
41	4.	5.	17	6.6	8.3
40	3.5	4.4	16	7,1	8.8
39	3.1	3.8	15	7.5	9.4
38	2.6	3.3	14	8.	10.
37	2.2	2.7	13	8.4	10.5
36	1.7	2.2	12	8.8	11.1
35	1.3	1.6	11	9.3	11.6
34	0.8	1.1	10	9.7	12.2
33	0.4	0.5	9	10.2	12.7
32	0.	0.	8	10.6	13.3
31	0.4	0.5	7	11.1	13.8
30	0.8	1.1	6	11.5	14.4
29	1.3	1.6	5	12.	15.
28	1.7	2.2	4	12.4	15.5
27	2.2	2.7	3	12.8	16.1
26	2.6	3.3	2	13.3	16.6
25	3.1	3.8	1	13.7	17.2

Combinations, properly so called, are only when certain quantities are taken two by two, three by three, &c. without any repetition of them, and without including the different changing of place.

Suppose the number of quantities to be combined to be q, and the exponent of the combination to be n, the number of combinations will be

$$\frac{q-n+1}{1} \times \frac{q-n+2}{2} \times \frac{q-n+3}{3} \times \frac{q-n \times 4}{4}$$ &c. till the number to be added be equal to n; or if n be the number of quantities to be combined, N their number of combina-

tions, and m their exponent, it will be universally.

$$N = \frac{n \times \overline{n-1} \times \overline{n-2} \times \overline{n-3} \ldots\ldots \times \overline{n-m+1}}{1 \times 2 \times 3 \times 4 \times \ldots\ldots \times m}$$

As one quantity has only one combination; two quantities, such as a, b, have three combinations, viz. a, ab, b; three quantities, as a, b, c, have seven combinations, viz. a, b, c, ab, ac, bc, abc, and so on; the number of these combinations will be expressed by the terms of the following series,

1, 3, 7, 15, 31, 63, 127, 255, 511, &c.

that is, the first term of this series gives the number of all the combinations of one quantity; the second gives the number of all the combinations of two quantities; the third of three; the fourth of four; and in general the term n gives the number of all the combinations of n quantities.

The terms of the above series arise from the difference between the terms of the two following n

2, 4, 8, 16, 32, 64. - - - - - 2

1, 1, 1, 1, 1, 1, - - - - - 1

whence the general term of our series is $2^n - 1$; which expression will, therefore, represent the number of all the combinations of n quantities. Suppose the number of quantities to be 8, the expression will be $2^8 - 1 = 255$.

Permutation regards only the order of quantities. Thus all the permutations of the letters a, b, c, are the six following, *abc*, *acb*, *cab*, *bac*, *bca*, *cba*. Hence, if n be the number of quantities to be permuted, and N the number of permutations, it will, be in general, $N = 1 \times 2 \times 3 \times 4 \times 5 \times 6 \times \ldots n$. For example, in how many different positions may 8 persons sit at table?

$1 \times 2 \times 3 \times 4 \times 5 \times 6 \times 7 \times 8 = 40{,}320$ positions.

Any number of different things being given, to find how many permutations or changes can be made out of them, taken n by n, or n quantities at a time, multiply continually $m \times \overline{m-1} \times \overline{m-2} \times \overline{m-3}$ &c. to n terms. For example, how many changes can be rung with three bells out of eight?

$$8 \times 7 \times 6 = 336.$$

If $V =$ all the variations or changes of m things, taken n at a time, then $\overline{m-n} \times V =$ all the changes of m things, taken $n \times 1$ at a time. Suppose $m = 7$ and $n = 4$, the changes will be $7 \times 6 \times 5 \times 4$, that is $V \times \overline{m-n}$

Any number of things m, being given, whereof there are

p things of one sort, and q things of another, to find how many changes can be made out of them all, multiply and divide according to this formula,

$$\frac{1 \times 2 \times 3 \times 4 \times 5 \times 6 \ldots \text{to } m}{1 \times 2 \times 3 \ldots \text{to } p \times 1 \times 2 \times 3 \text{ to } q}$$

The three letters a, b, c, for example, give six variations; but if they be reduced to this form, $a\ a\ a$, or a^3, these six variations become one $\frac{1 \times 2 \times 3}{1 \times 2 \times 3} = 1$. In like manner if all these quantities be different, as a, b, c, d, there will be 24 variations; but if they be all the same, as $a\ a\ a\ a$, or a^4, then these 24 will be but one $\frac{1 \times 2 \times 3 \times 4}{1 \times 2 \times 3 \times 4} = 1$. a, b, b, c, c, c, if all different, will admit of 720 changes; but because b occurs twice, and c thrice, the formula will be

$$\frac{1 \times 2 \times 3 \times 4 \times 5 \times 6}{1 \times 2 \times 3 \times 2 \times 3} = 60.$$

The number of permutations of m things, taken n at a time = like number of *combinations* × into 1, 2, 3, 4, 5, &c. . . . . to n terms.

For example, how many *combinations* can be made of three letters out of eight $\frac{8 \times 7 \times 6}{1 \times 2 \times 3} = 56$.

And how many *combinations* can be made with three letters of the alphabet, $\frac{24 \times 23 \times 22}{1 \times 2 \times 3}$ 2024.

Any number of quantities being given, to find the number of changes and alternations, which those quantities combined in all the manners possible (even with themselves) can undergo. Suppose two quantities, a and b; we shall have ab and ba, that is, two variations; and as each of these quantities may be combined with itself, we shall have aa and bb, that is, two more variations; the number of *combinations* and *alternations* will then be 4; if there were three quantities, as a, b, c, and the exponent of the variation were 2, the *combinations* will be three, as follows; ab, bc, ac, and the changes also three, ba, cb, ca; to which, if the three *combinations* of each quantity with itself aa, bb, cc, be added, we shall have the number of changes possible = 9.

In like manner, if the given quantities were 4, and the exponent 2, the number of changes and combinations would be 16; if 5, 25; and in general if n, n^2.

Suppose the exponent to be 3, and the quantities 3, the number of changes and combinations is found to be $27 = 3^3$ of a, b, c; viz. *aaa, aab, aba, baa, abb, aac, aca, caa, abc, bac, bca, acb, cab, cba, acc, cac, cca, bba, bab, bbb, bbc, cbb, bcb, bcc, cbc, ccc.*

If the quantities were 4, and the exponent 3, the number of changes and combinations would be $64 = 4^3$; and in general, if the number of quantities be n, and the exponent n, the number of changes and combinations would be n^n. The sum of this series will, therefore, give all the possible changes and combination of n quantities, $n^n + n^{n-1} + n^{n-2} + n^{n-3} + n^{n-4}$ &c. till the last term be n; which series i in a geometrical progression, whose first or smallest term is n^1, the greatest n^n, and the ratio n, the sum will therefore be $\frac{n^{n+1} - n}{n-1}$. Suppose $n = 6$ the number of all the possible combinations and changes, will be $\frac{6^7 - 6}{6-1} = 55989$.

French Measures of Length, &c.

Point.						Ft. In. Dec.
12	Ligne	-	-	-	-	0. 0, 0888125
144	12	Pouce	-	-	-	0. 1, 06575
1728	144	12	Pied	du Roi	-	1. 0, 789
10368	864	72	6	Toise	du Chatelet	6. 4, 734
38016	3168	264	22	$3\frac{2}{3}$	Perche Royal	23. 5, 358

An English foot is equal to 135,116 French lines.

A lieue commune de France, whereof 25 make a degree, is 2283 toises, equal to 2,7648 English miles.

One thousand toises are equal to $1065\frac{3}{4}$ fathoms.

Toises divided by 825, give English miles nearly.

The French arpent = 55206 square English feet = $1\frac{1}{4}$ Eng. acre nearly.

The Paris boisseau = 785,34 solid English inches = $1\frac{4}{9}$ peck nearly.

An English beer gallon of 282 cubic inches = 4,858 pintes de Paris.

The English quarter of 8 bushels = 22,53 boisseaux.

Hence one English bushel = 2,81625 boisseaux.

Two English pints, wine measure, = 1 pinte de Paris.

The French gros = 2dwts. 11,1 grains Troy weight.

Eight gros make an ounce, = 19dwts 16,25grs. Troy wt.

Eight onces, a marc; two marc, a livre.

A quintal is 1600 onces, = 131lb. 3 oz. Troy weight.

TABLE of the Length of a Pendulum vibrating Seconds at different Places, from the most exact Observations.

French Lignes	Engl. Inches.	Places of Observation, Lat. Height, Observers, &c
438 70	38,77	Under the Equ. 2434 toises high. by Bouguer.
438,83	38,95	Ditto, at 1466 ditto, the same.
439,07	38,89	Ditto, level with the sea, the same.
439,16	38,99	At Portobello, lat. 9° 34′ N. the same.
440,07	39,07	Cape of Good Hope, lat. 30° 55′ S.
440,17	39,08	At Geneva, lat. 46. 12. N. by M. Mallet.
440,52	39,108	At Paris, lat. 48° 50′ N. by Mairan.
440,62	39,1196	At London, lat. 51° 31′ N.
440,71	39,127	At Leyden, lat. 52° 9′ N. by Luſoss.
44 ,97	39,150	At Petersburg, lat. 59° 56′ N. by Mallet.
441,17	39,168	At Pello, lat. 66° 48′ N. by Maupertuis.
441,17	39,168	At Posnoi, lat. 67° 4′ N. by Mallet.

Several Degrees of the Meridian measured by the most renowned modern Astronomers.

Length in Paris Toises.	Length in Engl. Fathoms	Mean Latitude.	Observers Names.	Years in which they were observed.
57419	61194,3	66° 20′ N.	Maupertuis	1736 & 1737
57112	60867,	51°28′40″N	S. Dalby	1791,92,93, 1794.
57084	60851,	50° 41′N	Ditto	1787
57074	60826,6	49° 23′ N	Caſſini	1739. 40, 54
57091	60844,7	48° 43′ N	Liesgaring	Austria, 1768
57028	60777,6	45° N	Caſſini	1739, 40
57069	60821,3	44° 44′ N	Beccaria	1768
56979	60725,5	43° N	Boscovich	1752
56883	60628,5	39° 12′ N	Mason & Dixon	1764 to 1768
56750	60481,3	0° 0°	Condamine	1736 to 1743

The degree of a great circle perpendicular to the meridian at Greenwich, is 61251,1 fathoms. Hence the degree of the parallel to the equator on the spheroid, in the latitude of 51° 28′ 40″ N. is 38148,3 fathoms. A minute of time in that latitude, will be 19074,15 yards; and a second of time in the same latitude, will be 953,7 feet.

The ratio between the diameter and the circumference of a circle, Van Ceulen found to be, in numbers, as follows:

100000,000000,000000,000000,000000,000000,
314159,265358,979323,846264,338327,950288,

Its logarithm to seven places = 0,4971499.

Half the diameter multiplied into half the circumference, gives the area of the circle. The area multiplied by 4, gives the superficial contents of a globe; and the superficial contents multiplied by $\frac{1}{6}$ of the diameter, give the solid contents of a globe.

The progress of *sound* is equable; that is, sounds pass over half the space in half the time, a fourth part of the space in a fourth part of the time, and so on, whether they are produced by different bodies, such as guns, hammers, bells, &c. They are not altered by the state of the air; hot or cold, day or night, summer or winter, and in all changes of the atmosphere (winds excepted) the motion of sound is neither faster nor slower, but is only more or less loud from that variety of the medium. Also, whether the noise proceed towards the observer, or from him; whether the force, for example, of gunpowder be strong or weak, a greater or a smaller quantity, though it may increase or lessen the intensity of the sound, yet it neither accelerates or retards the motion. The mean progress of sound in one second of time, has been found to be 1142 English feet, by Messrs. Halley, Flamsteed, and many other observers; hence it passes over a mile in $9\frac{1}{4}$ half seconds, two miles in $18\frac{1}{2}$ half seconds, three miles in $27\frac{3}{4}$ half seconds, &c.; if the wind increase the rapidity of the sound, it is possible it may pass over 600 feet or more in half a second of time, instead of 571 feet; and, on the contrary, if it hinder the rapidity of the sound, it may not pass over 560 feet in the same time. One hundred and twenty feet of distance are, in general, allowed to the repeating a word of one syllable, and the echo returns in twice the time in which the voice reached the reflecting object. For example, if the obstacle reflecting the sound be distant

a furlong, the return of the echo will be made in the same time in which the primary sound would have described two furlongs, if it had not been interrupted. Hence the breadth of rivers, &c. may be collected; for, supposing the echo of a monosyllable to be reverberated by any obstacle, such as houses, &c. in six half seconds of time, say as $9\frac{1}{4}$ half seconds are to 5280, the feet in a mile, so are six half seconds to 3424,864 feet; the half of which, 1712,432 feet, is the distance of the object. By this means the height of thunder clouds, and the distance of thunder and lightning may be known: also the depth of wells, by listening to the noise of a stone thrown into them, and falling to the bottom. I have repeatedly, in a perfect calm, counted 88 beats of my Arnold's watch, from the sight of the flash of the Admiral's gun, in the Downs, to the report at Ramsgate, in Albion Place; hence the distance is found to be 7 miles, 4 furlongs, 35 poles. Arnold's time pieces beat five times in two seconds; hence if the beats be multiplied by 0,4, the product will be seconds; here $88 \times 0{,}4 = 35{,}2$ seconds $= 70{,}4$ half seconds, which being divided by $9\frac{1}{4}$, gives the above distance.

Laws respecting Bodies in Motion.

In successive equal parts of time, the spaces through which a body falls, are as 1, 3, 5, 7, &c.; and the acquired velocities are as 1, 2, 3, 4, &c. continually; that is, whatever velocity the body acquires at the end of the first second, it will acquire twice as much at the end of the next, three times as much at the end of the third, and so on; so that the velocities are as the times, and the spaces are as the squares of the times in falling. Thus, from all observations, it appears, that heavy bodies fall, in the first second of time, through a space equal to 16 English feet; in the next second, they will fall through three times 16, or 48 feet, which, added to the former 16, makes 64 feet, the whole space fallen through in two seconds of time; in the third second of time, bodies fall five times 16, or 80 feet; which, added to the above 64, makes 144 feet, the whole space fallen through in three seconds: and so on continually, increasing as the odd numbers 1, 3, 5, 7, 9, 11, in 1, 2, 3, 4, 5, 6, seconds of time.

In the following table, the numbers under T denote the

seconds of time, from 1 to 60, in which the body continues to fall; the numbers under S denote the spaces, in feet, through which the body falls in any second from 1 to 60; and the numbers under N denote the whole number of feet the body falls through at the end of any number of seconds from 1 to 60. Thus, between the end of the 15th and 16th second, the body falls 31 times 16 feet; and at the end of the 16th second, it has fallen through 4096 feet: in a quarter of a second from the instant of beginning to fall, a body would fall one foot; at the end of half that second, it will have fallen 4 feet; at the end of three quarters of that second, it will have fallen through 9 feet; and at the end of that whole second, through 16.

TABLE of Falling Bodies.

T	S	N	T	S	N	T	S	N	T	S	N
1	1	Feet 16	16	31	4096	31	61	15376	46	91	33856
2	3	64	17	33	4624	32	63	16384	47	93	35344
3	5	144	18	35	5184	33	65	17424	48	95	36864
4	7	256	19	37	5776	34	67	18496	49	97	38416
5	9	400	20	39	6400	35	69	19600	50	99	40000
6	11	576	21	41	7056	36	71	20736	51	101	41616
7	13	784	22	43	7744	37	73	21904	52	103	43264
8	15	1024	23	45	8464	38	75	23104	53	105	44944
9	17	1296	24	47	9216	39	77	24336	54	107	46656
10	19	1600	25	49	10000	40	79	25600	55	109	48400
11	21	1936	26	51	10816	41	81	26869	56	111	50176
12	23	2304	27	53	11664	42	83	28224	57	113	51984
13	25	2704	28	55	12544	43	85	29584	58	115	53824
14	27	3136	29	57	13456	44	87	30976	59	117	55696
15	29	3600	30	59	14400	45	89	32400	60	119	5760

The progression of falling bodies 16, 48, 80, 112, &c. is arithmetical, in which the first term $a = 16$, the difference $d = 32$. Now the sum of all the terms of an arithmetical progression is equal to the product of the sum of the extreme terms, multiplied by half the number of terms. Suppose a to be the first term, x the last, and n the number of terms, the sum of all the terms will be $\overline{a + x} \cdot \frac{n}{2} = s$, let d be the common difference; since the last term $x = a + \overline{n - 1} \cdot d$, we shall have $2a + dn - d \cdot \frac{n}{2} = s$, or $\frac{2an + dn^2 - dn}{2} = s$. Suppose it were required to know

how many feet a body will have passed through in an hour, at the above rate of falling; here $n = 3600$ and $s = 207360000$, the number of feet the body would fall in an hour, in a free and unresisting space; which, divided by 5280, (the number of feet in an English mile) gives 39272,7 for the number of miles.

The time wherein a body falls through a given space being given, to determine the time wherein it will fall through any other given space in the same medium. Since the spaces are as the square of times, find a fourth proportional to the space the heavy body moves through in the given time, the space required in the question, and the square of the given time, this fourth proportional will be the square of the time sought; its square root, therefore, being extracted, will give the time required. For example, if a body take four seconds of time in falling 256 feet, in what time would it fall 144 feet?

240 : 144 : : 16 : 9, then $\sqrt{9} = 3$ seconds.

The space a body falls through in a given time being given, to determine the space through which it will fall in any other given time; find a fourth proportional to the square of the time wherein the body falls through the given space, the square of the time wherein it should fall through the space required and the given space, the fourth proportional will be the space required. For example, suppose a body to fall 64 feet in two seconds of time, what space will it fall through in four seconds of time? 4 : 16 : : 64 : 256 feet.

The visible horizon is known to have a different extent at a different height of the eye, and is even variable at the same height of the eye, owing to a different refraction of the air. The semi-diameter of the earth being known, and the height of the eye being given, the extent of the visible horizon may be found in the following manner: to the semi-diameter of the earth, add the height of the eye, the arithmetical complement of the logarithm of this number, being added to the logarithm of the semi-diameter of the earth, will give the logarithm sine of an angle, whose complement will then be known, and consequently the arc; and may be found by the following table, in feet or miles. Different authors give a different extent to the visible horizon, either because they differ in the measure of the earth's semi-diameter from whence it is computed, or in their account of the measures they make use of. A degree of a great circle upon the earth is taken at 365640 feet in the construction of the following table.

TABLE shewing the Height of the apparent Level above the True, to the thousandth Part of an Inch.

If the distance of the object from the place of the spectator be which measured in a great circle upon the earth amounts to	Seconds.	Feet.	In.	Dec.	In. Dec. the height of the apparent level above the true will be
	1	101	6	8	0,003
	2	203	1	6	0,012
	3	304	8	4	0,027
	4	406	3	2	0,048
	5	507	10	0	0,074
	6	609	4	8	0,106
	7	710	11	6	0,145
	8	812	6	4	0,189
	9	914	1	2	0,239
	10	1015	8	0	0,295
	11	1117	2	8	0,357
	12	1218	9	6	0,425
	13	1320	4	4	0,499
	14	1421	11	2	0,579
	15	1523	6	0	0,665
	16	1625	0	8	0,756
	17	1726	7	6	0,854
	18	1828	2	4	0,947
	19	1929	9	2	1,067
	20	2031	4	0	1,182
	21	2132	10	8	1,303
	22	2234	5	6	1,420
	23	2336	0	4	1,563
	24	2437	7	2	1,702
	25	2539	2	0	1,847
	26	2640	8	8	2,001
	27	2742	3	6	2,154
	28	2843	10	4	2,316
	29	2945	5	2	2,485
	30	3047	0	0	2,659
	31	3148	6	8	2,839
	32	3250	1	6	3,026
	33	3351	8	4	3,218
	34	3453	3	2	3,416
	35	3554	10	0	3,619
	36	3656	4	8	3,829

If the distance of the object from the place of the spectator be which measured in a great circle upon the earth, amounts to	Seconds.	Feet.	In.	Dec.	In. Dec. the height of the apparent level above the true will be
	37	3757	11	6	4,045
	38	3859	6	4	4,267
	39	3961	1	2	4,494
	40	4062	8	0	4,728
	41	4164	2	8	4,967
	42	4265	9	6	5,212
	43	4367	4	4	5,463
	44	4468	11	2	5,720
	45	4570	6	0	5,983
	46	4672	0	8	6,252
	47	4773	7	6	6,527
	48	4875	2	4	6,808
	49	4976	9	2	7,094
	50	5078	4	0	7,387
	51	5179	10	8	7,685
	52	5281	5	6	7,989
	53	5383	0	4	8,300
	54	5484	7	2	8,616
	55	5586	2	0	8,938
	56	5687	8	8	9,266
	57	5789	3	6	9,600
	58	5890	10	4	9,940
	59	5992	5	2	10,285
	60	6094	0	0	10,637

Continuation of the Table shewing the Height of the apparent Level above the True, to the thousandth Part of an Inch.

If the distance of the object from the place of the spectator be	Minutes	which measured in a great circle upon the earth, amounts to	Feet.	The height of the apparent level above the true will be	Feet. In. Dec.	If the distance of the object from the place of the spectator be	Min.	which measured in a great circle upon the earth, amounts to	Feet.	The height of the apparent level above the true will be	Feet. In. Dec.
	1		6094		0 10 637		31		188914		851 10 080
	2		12188		3 6 548		32		195008		907 8 206
	3		18282		7 11 732		33		210102		965 3 606
	4		24376		14 2 191		34		207196		1024 8 280
	5		30470		22 1 923		35		213290		1085 10 227
	6		36564		31 10 929		36		219384		1148 9 448
	7		42658		43 5 209		37		225478		1213 5 493
	8		48752		56 8 763		38		231572		1279 11 712
	9		54846		71 9 591		39		237666		1348 2 755
	10		60940		88 7 692		40		240760		1418 3 072
	11		67034		107 3 067		41		249854		1490 0 663
	12		73128		127 7 716		42		255948		1563 7 527
	13		79222		149 10 025		43		262042		1638 11 665
	14		85316		173 8 836		44		268136		1716 1 077
	15		91410		199 5 307		45		274230		1794 11 763
	16		97504		226 11 052		46		280324		1875 7 723
	17		103598		256 2 070		47		286418		1958 0 956
	18		109692		287 2 362		48		292512		2042 3 464
	19		115786		319 11 928		49		298606		2128 3 245
	20		121880		354 6 768		50		304700		2216 0 300
	21		127974		390 10 882		51		310794		2305 6 629
	22		134068		429 0 269		52		316888		2396 10 232
	23		140162		468 10 931		53		322982		2489 11 108
	24		146256		510 6 866		54		329076		2584 9 259
	25		152350		554 0 075		55		335170		2681 4 683
	26		158444		599 2 558		56		341264		2779 9 381
	27		164538		646 2 314		57		347358		2879 11 353
	28		170632		694 11 345		58		353452		2981 10 598
	29		176726		745 5 649		59		359546		3085 7 199
	30		182820		797 9 928		60		365640		3191 0 912

Suppose an arc of a great circle upon the earth to be given in seconds or minutes, to find the length thereof in English measure; for example, an arc of 8″ is 812 feet, 6 inches, and 4 tenths, by the above table; an arc of 20′ is 121880 English feet. Another use of the table is, an arc of a great circle upon the earth being given in

seconds or minutes, or in feet and inches, to find the height of the apparent level above the true; thus if an arc be 20″ or 2031 feet 4 inches, the height of the apparent level above the true is 1 inch 182. Thus again, if the distance of the place of an object from the place of the observer be 30′ or 182820 feet, the height of the apparent level above the true is 797 feet, 9,928 inches. If the distance of a mountain, whose top is in the sensible horizon, be 15′ or 91410 feet, the height of the mountain is 199 feet, 5,307 inches.

If the distance of an object given be a number of feet which is not in the table, take the number in the table which is nearest to the number given, and then, as the square of the number thus taken is to the square of the number given, so is the height of the apparent level above the true, corresponding to the number taken, to the height of the apparent level, which corresponds to the number given. Thus, if it be inquired what is the height of the apparent level above the true, when the distance of the object is 200000 feet, the nearest number to this in the table is 201102, the height of the level corresponding thereto is 965 feet; then, as the square of 201102 is to the square of 200000, so is 965 to a fourth number of feet, 954, by which the apparent level exceeds the true at the distance of 200000 feet.

We may also find by this table, how far we may see in a true horizon at sea, when the eye is raised to any given height above the surface of the water. Thus, suppose the eye of an observer to be 22 feet 2 inches above the surface of the sea, he will see to the distance of 30470 feet all round him, or to the distance of 5 geographical miles; for against 22 feet 1,923 inch. in the right hand column, is placed 30470 feet in the middle column, and 5 minutes, or geographical miles, in the first column. Another use of the table is for levelling; in order to convey water from one place to another, for where the distance is many miles, the difference between the apparent level and the true, must be taken into the account. Suppose it were required to cut a canal, whose bottom shall be a true level, of the length of 5078 feet, the common method will not give a true level at that distance; for by the table, at the distance of 5078 feet, the apparent level is 7 inches above the true; therefore, to make a true level, one end must be sunk 7 inches lower than the apparent level directs.

The latitude of Greenwich Observatory is 51° 28′ 40″ N.
The latitude of the R. Observatory at Paris is 48° 50′ 14″ N.

The difference of meridians of Greenwich and Paris, as deduced by Mr. J. Dalby from General Roy's Measurements, was found to be 2° 20′ 4″, 9, or 9′ 20″, 4, in time E. of Greenwich.

The principal town in the isle of Ferro is 19° 53′ 45″ west of Paris; hence the longitude of Ferro from Greenwich is 17° 33′ 40″ west.

	Latitude.	From Greenwich. *Longitude, in time.* h. m. sec.	
St. Paul's	51° 30′ 49″ N.	0. 0. 23.12. W	Gen. Roy.
St. James's Church	51. 30. 30″,7 N.	0. 0. 32.33. W	Gen. Roy.
Richmond R. Observatory	51. 28. 7″,9 N.	0. 1. 14.82. W	Gen. Roy.
Mr. Cavendish's at Clapham	51. 27. 12″,7 N.	0. 0. 34.61. W	Gen. Roy.
Highbury House (Aubert)	51° 33′ 12″,8 N.	0. 0. 23.37. W	
The Lizard (Bradley)	49. 57. 30″ N.	0. 21′ 13″,5. W or 5° 18′ 15″ in deg.	

Oxford Observatory 51° 45′ 15″ N. lat.; long. 1° 15′ 45″, or 5′ 3″ time W. (Hornsby.)
Windsor Castle, lat. 51° 28′ 15″ N; long. 2′ 24″, 5 in time, W.
Cambridge, lat. 52° 17′ 0″ N.; long. 0° 5′ 45″ E. or 0^h 0′ 23″ in time E.
Exeter, lat. 50° 44′ N.; long. 3° 34′ 30″ W.
Falmouth, lat. 50° 8′ N.; long. 5° 28′ 20″ W.
Plymouth Town, lat. 50° 26′ N.; long. 4° 18′ 51″ W.
Portsmouth, lat. 50° 49′ N.; long. 1° 5′ W.
Ramhead, lat. 50° 23′ N.; long. 4° 22′ 25″ W.
Edyston, lat. 50° 12′ N.; long. 4° 25′ 18″ W.
St. Agnes' Lighthouse, lat. 49° 56′ N.; long. 7° 14′ W.
Start Point, lat. 50° 9′ N.; long. 3° 11′ 15″ W.
Sherburn Castle, lat. 51° 39′ 25″ N; long. 1° 0′ W.
Edinburgh, lat. 55° 57′ 57″ N.; long. 0° 13′ 13″ W. of Greenwich, in time.
Wakefield, lat. 53° 41′ N.; long. 1° 33′ 30″ W.
York, lat. 53° 57′ 45″ N.; long. 0^h 4′ 31″ W. of Greenwich, in time. (Pigott)
Ramsgate, lat. 51° 19′ 15″ N.; long. 5′ 38″ E. of Greenwich, in time. (Aubert)

Scarborough, lat. 54° 18′ N.; long. 0° 15′ W.	Uncertain to seconds.	
Spurn Point, lat. 53° 35′ N.; long. 0° 30′ E.		
Sunderland, lat. 54° 55′ N.; long. 1° 0′ W.		
Torbay, lat. 50° 34′ N.; long. 3° 36′ W.		
Weymouth, lat. 50° 40′ N.; long. 2° 34′ W.		

Whitby, lat. 54° 30′ N.; long. 0° 50′ W.
Whitehaven, lat. 54° 25′ N.; long. 3° 15′ W.
Lynn Regis, lat. 52° 45 N.; long. 0° 28′ E.
Tenby, lat. 51° 42′ N.; long. 5° 5′ 0″ W.
Swansea, lat. 51° 38′ N.; long. 4° 0′ W.
Harwich, lat. 52° 11′ N.; long. 1° 18′ E.
Hull, lat. 53° 50′ N.; long. 0° 28′ W.
Bridlington Bay, lat. 54° 7′ N.; long. 0° 4′ E.

} Uncertain to Seconds.

Copenhagen Observatory, lat. 55° 41′ 4″ N.; long. from Greenwich, 0^h 51′ 1″ in time, E.
Landscrone, Sweden, lat. 55° 52′ 23″ N.; long. from Copenhagen, 0° 15′ 16″ E.
Kullen (Lighthouse) Sweden, lat. 56° 18′ 3″ N.; long. from Cop. 0° 7′ 58″ W.
Korsör (Lighthouse) Seland, lat. 55° 20′ 22″ N.; long. from Cop. 0° 1′ 27″ W.
Skagen (Lighthouse) North Jutland, lat. 57° 43′ 44″ N.; long. from Cop. 1° 57′ 55″ W.
Hesselöe (isle) Kattegat, lat. 56° 11′ 46″; long. from Cop. 0° 51′ 44″ W.
Anholt (Lighthouse) Kattegat, lat. 56° 44′ 20″ N.; long. from Cop. 0° 55′ 24″ W.

} Bugge, Professor at Copenhagen.

Funchal, lat. 32° 33′ 35″ long. 1^h 6′ 55″ W. of Greenwich. (Heberden)
Cavan, (Ireland) lat. 54° 51′ 40″ 8; long. 9^h 23′ 10″ W. in time. (Mason)

Bruxelles, lat. 50° 51′ 0″ N.; long. 8′ 7″ in time, E. of Paris Observatory. (Pigott)
Louvain, lat. 50° 53′ 3″ N.; long. 9′ 37″ in time, E. of ditto. (Pigott)
Namur, lat. 50° 28′ 32″ N.; long. 9′ 39″ in time, E of ditto. (Pigott)
Luxembourg, lat. 49° 37′ 6″ N.; long. 15′ 27″ in time, E of ditto. (Pigott)
Ostende, lat. 51° 15′ 10″ N.; long. 2′ 33″ in time, E of ditto. (Pigott)
Tournai, lat. 50° 36′ 57″ N. (Pigott)

Alba, lat. 41° 43 50″ N; long. from Ferro, 30° 10′ 31″ E
Ancona, lat. 53° 37′ 54″ N; long. from do. 31° 1′ 22″ E
Bologna, lat. 44° 29′ 39″ N; long. ditto, 28° 52′ 33″ E
Cesena, lat. 44° 8′ 25″ N; long. ditto, 29° 45′ 35″ E
Civita Vecchia, lat. 42° 5′ 24″ N.; long. ditto, 29° 17′ 0″ E
Faenza, lat. 44° 17′ 19″ N; long. ditto, 29° 24′ 4″ E
Fano, lat. 43° 51′ 0″ N; long. ditto, 30° 32′ 8″ E
Ferrara, lat. 44° 49′ 56″ N; long. ditto, 29° 8′ 40″ E
Frascati, lat. 41° 48′ 22″ N; long. ditto, 30° 12′ 4″ E
Loreto, lat. 43° 27′ 0″ N; long. ditto, 31° 7′ 20″ E
Narni, lat. 42° 31′ 17″ N; long. ditto, 30° 1′ 50″ E
Orvieto, lat. 42° 43′ 24″ N; long. ditto, 29° 38′ 19″ E
Perugia, lat. 43° 6′ 46″ N; long. ditto, 29° 54′ 28″ E
Pesaro, lat. 43° 55′ 1″ N; long. ditto, 30° 25′ 51″ E
Ravenna, lat. 44° 25′ 5″ N; long. ditto, 29° 23′ 6″ E
Rimini, lat. 44° 3′ 43″ N; long. ditto, 30° 5′ 6″ E
Roma, lat. 41° 53′ 54″ N; long. ditto, 30° 0′ 0″ E
Senegaglia, lat. 43° 43′ 16″ N; long. ditto, 30° 44′ 0″ E
Spoleto, lat. 42° 44′ 50″ N; long. ditto, 30° 15′ 31″ E
Terni, lat. 42° 34′ 25″ N; long. ditto, 30° 10′ 26″ E
Terracina, lat. 41° 18′ 14″ N; long. ditto, 30° 45′ 37″ E
Tivoli, lat. 41° 57′ 49″ N; long. ditto, 30° 19′ 3″ E
Velletri, lat. 41° 41′ 16″; N; long. ditto, 30° 17′ 45″ E
Viterbo, lat. 42° 24′ 54″ N; long. ditto, 29° 37′ 49″ E
Urbino, lat. 43° 43′ 36″ N; long. ditto, 30° 9′ 20″ E

} Boscovich.

Gottingen Observatory, lat. 51° 31′ 54″ N; long. from Greenwich, 0^h 39′ 36″ in time, E
Geneva, lat. 46° 12′ 0″ N; long. from Gr. 0^h 26′ 20′ in time.
Canton, lat. 23° 7′ 30″ N; long. ditto, 7^h 32′ 8″ in time, or 113° 2′ 0″ E of Greenwich.
St. Petersburg, lat. 59° 56′ 0″ N; long. ditto, 2^h 1′ 20″ in time, E
Stockholm, lat. 59° 20′ 31″ N; long. ditto, 1^h 12′ 11″ in time, E
Vienna, lat. 48° 12′ 48″ N; long. ditto, 1^h 5′ 30″ in time, E
Aix, lat. 43° 31′ 35″ N; long. 0^h 21′ 45″ in time, E of Greenwich.
Amiens, lat. 49° 53′ 38″ N; long. 0^h 9′ 12″ in time, E of ditto.
Antibes, lat. 43° 34′ 50″ N; long, 0^h 28′ 34″ in time, E of ditto.
Avignon, lat. 43° 57′ 25″ N; long. 0^h 19′ 14″ E of ditto, in time.
Balasore, lat. 21° 20′ 0″ N; long. 5^h 44′ 0″ E of ditto, in time.
Bayonne, lat. 43° 29′ 21″ N; long. 0^h 6′ 0″ in time, W of ditto.
Berlin, lat. 52° 32′ 30″ N; long. 0^h 53′ 45″ E of ditto, in time.
Besancon, lat. 47° 13′ 45″ N; long. 0^h 24′ 10″ E of ditto, in time.
Bourdeaux, lat. 44° 50′ 18″ N; long. 0^h 2′ 19″ W of ditto, in time.
Brest, lat. 48° 23′ 0″ N: long. 0^h 18′ 3″ W of ditto, in time.
Cadiz, lat. 36° 31′ 7″ N; long. 6^h 24′ 5″ W of Greenwich, in time.
Caen, lat. 49° 11′ 10″ N; long, 0^h 1′ 27″ W of ditto, in time.
Fort William (Calcutta) lat. 22° 36′ N; long. 5^h 53′ 43″ E of ditto, in time.

Cayenne, lat. 4° 56′ N; long. 3^h 29′ W of Greenwich, in time.
Cherburgh, lat. 49° 38′ 26″ N; long. 0^h 6′ 33″ W of Gr. in time.
Cape Comorin, lat. 7° 56′ N; long. 5^h 12′ 20″ E of ditto, in time.
Constantinople, lat. 41° 0′ 0″ N; long. 1^h 53′ 34″ E of ditto, in time.
Dantzic, lat. 54° 22′ N; long. 1^h 14′ 4″ E of ditto, in time.
Dijon, lat. 47° 19′ 22″ N; long. 0^h 20′ 10″ E of ditto, in time.
Florence, lat. 43° 46′ 30″ N; long. 0^h 44′ 8″ E of ditto, in time.
Genoa, lat. 44° 25′ N; long. 0^h 34′ 23″ E of ditto, in time.
Madras, lat. 13° 13′ N; long. 5^h 20′ 9″ E of ditto, in time.
The Cape Town, lat. 33° 55′ 42″ S; long. 1^h 13′ 33″ E of ditto, in time.
St. Helena, lat. 15° 55′ S; long. 0^h 23′ 16″ W of ditto, in time.
Madrid, lat. 40° 25′ N; long. 0^h 14′ 58″ W of ditto, in time.

Weights and Measures compared.

A Winchester bushel ought to be eight inches deep, and $18\frac{1}{2}$ diameter.

The wine gallon is 231 cubic inches.

The corn gallon 268.8 cubic inches.

Twenty cubic feet of hay is about a hundred weight.

Fifty-six lb. of butter make a firkin, which is 4 stone avoirdup.

Sixty cubic feet of Newcastle coals is a chaldron, or 36 bushels.

A bushel of wheat weighs about 60lb. avoirdupois.

A load of hay is 36 trusses, and a truss is 4st. or half a hundred.

One lb. Troy of water is $22\frac{3}{4}$ solid inches.

One lb. avoirdupois of water is $27\frac{1}{2}$ solid inches.

One inch of water weighs 0,58 ounces avoird. or 253,182 grs.

A cubic foot of water weighs 76lb. Troy, or $62\frac{1}{2}$ avoirdupois, which is 1000 ounces, and contains $6\frac{1}{8}$ ale gallons.

A wine gallon of water weighs 8,35lb. avoirdupois.

An ale gallon of water weighs 10,2lb. avoirdupois.

A ton of water weighs $18\frac{3}{4}$ hundred weight.

A cylinder of water of x inches diameter, and a yard high, contains $\frac{1}{170}x^2$ ale gallons, and weighs $1\frac{1}{5}x^2$ pounds avoirdupois.

A cubic inch of standard gold weighs 10,93 ounces avoirdupois, or 9,962 ounces Troy.

A cubic inch of standard silver weighs 6,096 ounces avoirdupois, or 5,556 ounces Troy.

A cubic foot of wheat weighs 48lb. avoirdupois.

A cubic foot of standard gold weighs 7524921,7 grains, or 1306lb. Troy 4oz. 18pwts. $9\frac{7}{10}$grs.; and out of this quantity $58135\frac{1}{4}$ guineas may be coined. The standard for coinage gold is 11 ounces of pure gold, and 1 ounce of copper; $44\frac{1}{2}$ guineas are coined out of a Troy pound, or 5760 grains of gold. Hence the standard weight of a guinea is 129,4382 grains.

Comparative Properties of Metals.

Metals ductile under the hammer, present themselves in the following order, *gold, silver, copper, iron, tin,* and *lead.*

Gold may be beat so that the thickness of the leaf will be less than $\frac{1}{282000}$ part of an inch. Sixteen pennyweights of gold may be made to cover 151,24 square feet.

One grain of gold will cover a wire of 294 feet.

One grain of silver may be stretched out to 5 feet 8 inches English measure, and two inches in breadth.

Copper may be beat into leaves almost as thin as gold, and they are made use of for the vulgar kinds of gilding.

The tin sheet used in various arts, is commonly about $\frac{1}{6000}$ part of an inch, but may be extended twice as much in its dimensions without difficulty.

Metals ductile through the wire-drawer's plate, form the following series, *gold, iron, copper, silver, tin,* and *lead.*

A wire of gold, of one-tenth of an inch in thickness, will support 500lb weight without breaking.

A wire of *iron* of the same thickness, will hold 450lb.

A wire of *copper* of the same diameter, will support 300lb.

A *silver* wire of one-tenth of an inch thick, will bear 270lb.

A wire of *tin* of the same dimensions, cannot hold more than 49½lb. without breaking.

A wire of *lead* only supports 29¼lb. without breaking.

Platina has been drawn into a wire of $\frac{1}{1940}$ of an inch in diameter, and was found to have more strength than a wire of gold.

The order in which metals melt with common heat, is as follows, *tin, lead, brass, copper, silver, gold, iron.*

Tin melts at the 415th degree of Fahrenheit's thermometer.

Lead melts at about 540 degrees of the same thermometer.

Brass at 3807 degrees of ditto.

Copper at 4587 degrees of ditto.

Silver at 4717 degrees of ditto.

Gold melts at 5237 degrees of ditto.

Cast iron at 17977 degrees of ditto.

Platina is not fusible by the most intense fire, but melts in the focus of a strong burning lens, and very easily by electricity.

The order in which the metals are to be ranked, with respect to the power of electricity over them, is as follows; *lead, tin, iron, brass, copper, silver, gold.* Hence, copper would be a much greater security, as a conductor, to guard a building from lightning than iron, besides its being less liable to rust.

A TABLE, shewing the specific Gravity of Metals to distilled Water, and the Weight of a Cubic Inch of each, in Parts of a Pound Avoirdupois.

	Spec. Grav.	*W. lb. Avoirdupois.*
Platina, in wire	21042	0, 76107
Pure gold, cast	19258	0, 71036
Pure silver, cast	10474	0, 37796
Mercury	13568	0, 49074
Lead, fused	11352	0, 40965
Copper, fused	7788	0, 28168
Iron, cast	7207	0, 26067
Tin, fused	7291	0, 26371
Bismuth	7893	0, 35529
Wickel	8660	0, 31323
Arsenic	5763	0, 20844
Cobalt	7812	0, 28255
Zinc -	7191	0, 26009
Antimony	6702	0, 24240
Manganese	6850	0, 24776
Wolfran	17600	0, 63657

Hence the lightest of the metals is nearly six times heavier than an equal bulk of distilled water.

The specific gravity of solids is determined by weighing them, first in air, and then in water. The loss of weight arising from the action of the water, is equal to that of a mass of the fluid possessing the same dimensions as the solid itself. Whence it is easy to construct a general table of specific gravities, by reducing the proportion of the absolute weight to the loss sustained by immersion, into terms of which that expressing water shall be unity. The specific gravity of fluids is ascertained by weighing a known body immersed in them; for the loss by immersion will accurately shew the weight of the same bulk of the fluid.

TABLE of the Correction to be applied to the Time of High Water on the Syzigies to give the Time of High Water on any other Day. (BOUGUER.)

Interval of time.		After new moon. add.		Before the first quart. add.		After the first quart. add.		Before the full moon. sub.		After the full moon. add.		Before the last quart. add.		After the last quart. add.		Before new moon. sub.		Interval of time.	
D.	H.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	D.	H.
0	0	0	0	5	6	5	6	0	0	0	0	5	6	5	6	0	0	0	0
	3	0	4	4	58	5	14	0	4	0	4	4	58	5	14	0	4		3
	6	0	8	4	51	5	22	0	9	0	8	4	51	5	22	0	9		6
	9	0	13	4	44	5	31	0	13	0	13	4	44	5	31	0	13		9
	12	0	17	4	37	5	40	0	18	0	17	4	37	5	40	0	18		12
	15	0	22	4	30	5	50	0	23	0	22	4	30	5	50	0	23		15
	18	0	26	4	23	6	0	0	27	0	26	4	23	6	0	0	27		18
	21	0	31	4	16	6	10	0	32	0	31	4	16	6	10	0	32		21
1	0	0	36	4	9	6	20	0	37	0	36	4	9	6	20	0	37	1	0
	3	0	41	4	3	6	29	0	42	0	41	4	3	6	29	0	42		3
	6	0	45	3	56	6	39	0	47	0	45	3	56	6	39	0	47		6
	9	0	49	3	50	6	49	0	52	0	49	3	50	6	49	0	52		9
	12	0	54	3	44	6	58	0	57	0	54	3	44	6	58	0	57		12
	15	0	58	3	38	7	8	1	2	0	58	3	38	7	8	1	2		15
	18	1	2	3	32	7	18	1	7	1	2	3	32	7	18	1	7		18
	21	1	7	3	27	7	27	1	12	1	7	3	27	7	27	1	12		21
2	0	1	11	3	21	7	37	1	17	1	11	3	21	7	37	1	17	2	0
	3	1	15	3	16	7	46	1	23	1	15	3	16	7	46	1	23		3
	6	1	19	3	11	7	56	1	28	1	19	3	11	7	56	1	28		6
	9	1	24	3	6	8	5	1	33	1	24	3	6	8	5	1	33		9
	12	1	28	3	1	8	14	1	39	1	28	3	1	8	14	1	39		12
	15	1	32	2	56	8	23	1	45	1	32	2	56	8	23	1	45		15
	18	1	37	2	50	8	31	1	51	1	37	2	50	8	31	1	51		18
	21	1	41	2	45	8	39	1	57	1	41	2	45	8	39	1	57		21
3	0	1	46	2	40	8	47	2	4	1	46	2	40	8	47	2	4	3	0
	3	1	50	2	35	8	55	2	10	1	50	2	35	8	55	2	10		3
	6	1	54	2	30	9	2	2	16	1	54	2	30	9	2	2	16		6
	9	1	59	2	25	9	9	2	23	1	59	2	25	9	9	2	23		9
	12	2	3	2	21	9	17	2	29	2	3	2	21	9	17	2	29		12
	15	2	7	2	16	9	24	2	36	2	7	2	16	9	24	2	36		15
	18	2	12	2	12	9	31	2	44	2	12	2	12	9	31	2	44		18
	21	2	16	2	7	9	37	2	51	2	16	2	7	9	37	2	51		21
4	0	2	21	2	3	9	44	2	58	2	21	2	3	9	44	2	58	4	0

The above table being used with the time of either phase of the moon, will, in general, shew the time of high water within a quarter of an hour of the truth at any known port, where the tides are not greatly influenced by the winds. If the time to be sought in this table be between the hours in the outside columns, the equation is to be corrected by proportional parts.

The time of high water in any port on the syzigies being known, to find the time of high water in that port on any other day, seek in the given month, or in that immediately preceding or following it, for the time of that phase which happened nearest to the given day, and take the difference of those times, in the above table; this difference of time gives an equation, which being applied to the time of the syzigie high water for the given port, as its title directs, gives the time of the afternoon high water in that port. If the time of the morning high water be required, do as above directed in the first article, and increase the said difference by 12 hours, if the given day fall before the phase; or diminish it by 12 hours, when after the phase. The equation to this time applied to the syzigie time, gives the morning time of high water: for example, at Portsmouth, where it is high water on the syzigies at $11^h\ 15'$: required the afternoon and morning times of high water on the 2d of February, 1796. To February 2d, the nearest phase, is the last quarter on January $31^d\ 9^h\ 2'$, and as February the 2d may be called January 33d, their difference or time after the last quarter is $1^d\ 14^h\ 58'$; the equation to which, in the above table, is $7^h\ 8'$.

Then $11^h\ 15' + 7^h\ 8' = 18^h\ 23'$ or high water at $6^h\ 23'$. P. M.

Again $1^d\ 14^h\ 58' - 12^h = 1^d\ 2^h\ 58'$, the equation to which is $6^h\ 29'$.

Then $11^h\ 15' + 6^h\ 29' = 17^h\ 44'$, or high water at $5^h\ 44'$ A. M.

The time of high water in any port being observed on any day, to find the time of high water in that port on the syzigies; 1st. by the difference of longitude reduce the given time to Greenwich, then take the difference between this time and that of the moon's nearest phase; the equation in the above table to this difference, applied to the said Greenwich time, contrary to what its title directs, will give the syzigie time of high water at that port. For example, suppose on the 11th of March, 1796, at $8^h\ 11'$ P. M. it was observed to be high water in the river Senegal, what is the time of high water on the full and change days? The river

Senegal is west of Greenwich 16° 20′ = 1ʰ 5′, the nearest phase to March 11th is new moon at 9ᵈ 1ʰ 0′, which, fitted to Senegal, makes 8ᵈ 23ʰ 55′. The 11th day is after new moon 2ᵈ 0ʰ 5′, its equation 1ʰ 11′, which is subtractive, contrary to its title in the table. Then 8ʰ 11′ — 1ʰ 11′ = 7ʰ, the time of high water on the days of the full and change of the moon in the river Senegal.

Hours of High Water on the Syzigies in different Parts of the World.

Amsterdam, 3ʰ 0′	Foreland, N. 9ʰ 45′	Milford, 5ʰ 15′
Aberdeen, 0ʰ 45′	Foreland, S. 9ʰ 45′	Margate, 11ʰ 15′
Bristol, 6ʰ 45′	Flambor. Head, 4ʰ 0′	Needles, 10ʰ 15′
Bridlington Bay, 3ʰ 45′	Gravesend, 1ʰ 30′	Nore, 0ʰ 0′
Beachy Head, 0ʰ 0′	Groix, Isle de, 1ʰ 45′	Nantes, 3ʰ 45′
Boulogne, 10ʰ 30′	Guernsey, 1ʰ 30′	Orfordness, 9ʰ 45′
Belleisle, 3ʰ 30′	Gibraltar, 0ʰ 9′	Plymouth, 6ʰ
Brest Road, 3ʰ 45′	Humber, entrance of,	Portland, 8ʰ 15′
Bourdeaux, 7ʰ 15′	5ʰ 13′	Portsmouth, 11ʰ 15′
Cork, 6ʰ 30′	Hartlepool, 3ʰ 0′	Rye, 11ʰ 15′
Cape Clear, 4ʰ 30′	Hull, 6ʰ 0′	Ramsgate, 11ʰ
Cadiz, 1ʰ 10′	Harwich, 11ʰ 15′	Rochelle, 3ʰ 45′
Cherbourg, 7ʰ 45′	Holyhead, 1ʰ 30′	Scarborough, 3ʰ 45′
Calais, 11ʰ 30′	Hamburgh, 6ʰ	Scilly Isles, 3ʰ 45′
Cancale Bay, 6ʰ	Havre, le, 9ʰ	Sunderland, 3ʰ 30′
Dartmouth, 6ʰ 30′	Hague, Cap le, 12ʰ 30′	Southampton, 0ʰ 0′
Dungeness, 9ʰ 45′	Isle Dieu, 3ʰ 0′	Start Point, 6ʰ 45′
Dover, 11ʰ 30′	Land's End, 7ʰ 30′	St. Malo, 6ʰ
Downs, 1ʰ 15′	Lizard, 7ʰ 30′	Tinmouth, 3ʰ
Dun. Isle of W. 9ʰ 45′	Lisbon, 2ʰ 15′	Torbay, 5ʰ 15′
Dublin, 9ʰ 15′	Liverpool, 11ʰ 15′	Texel Island, 7ʰ 30′
Dieppe, 10ʰ 30′	Lowestoffe, 9ʰ 0′	Waterford, 6ʰ 30′
Dunkirk, 0ʰ 0′	Lime, 7ʰ 0′	Weymouth, 7ʰ 20′
Edystone, 5ʰ 30′	Lynn, 6ʰ 45′	Whitby, 3ʰ
Elbe Mouth, 0ʰ 0′	London, 3ʰ	Yarmouth, 9ʰ 45′
Falmouth, 5ʰ 30′	Loire, Mouth of, 3ʰ 15′	Youghall, 4ʰ 30′

Besides the times of high water in the preceding Table, the following times serve for coasts of considerable extent, and will serve nearly for the places on those coasts.

Finmark, or N. N. W. coast of Lapland, 1ʰ 30′.

Friesland coast, 7ʰ 30′. Zealand coast, 1ʰ 30′. Jutland isles, 0ʰ 0′.

Flanders coast, 0ʰ 0′. Picardy and Normandy coasts, 10ʰ 30′.

Biscay, Gallician, and Portugal coasts, 3ʰ 0′.

Irish W. coast, 3ʰ 0′. Irish S. coast, 5ʰ 15′.

Africa W. coast, 3ʰ 0′. America W. coast, 3ʰ.

America E. coast, 4ʰ 30′.

The principal sums owing to the public creditors of the nation, and usually known by the name of the National Debt, are divided into three classes, the redeemable, and the irredeemable funded debt, and the unfunded debt. The redeemable debt consists of such principal sums as the legislature may cancel without the consent of the proprietors of them, upon the payment of the said principal sums, and all interest due thereon. The irredeemable debt consists of certain annual sums, granted for a fixed number of years, which cannot be redeemed without the consent of the proprietors. Both these classes of debts are called funded debts, are transferable; and have had funds appropriated by parliament for the payment of all the annuities annually growing due upon them, and from which they are paid half yearly. The third class, being the unfunded debt, consists of a variety of demands upon government remaining undischarged; but for which certain securities have been given by administration, till provision should be made by parliament, either to pay them, or to pass them to account in some old, or new, created fund. The securities given are known by the names of navy and victualling bills, exchequer bills, &c.

The stock or capital of our public companies has been raised by authority of parliament; and by the same authority has been confined to a limited sum: so that as soon as the sum allowed to be raised was completed, the number of proprietors was likewise ascertained, and no person whatever could afterwards be admitted on the same footing; but every proprietor had a power reserved to him, his heirs and executors, of transferring or assigning over his right in the said stock to whom he thought proper.

The government Annuities and other securities for money, stand nearly in the same light, with respect to the first raising of the sums granted, in aid of government, as the stocks of companies. The money is raised by authority of parliament, the sum is limited; and after the subscription is full, no more contributors can be admitted. The same method has been taken of opening transfer books, &c.

The Amount of the Capitals at the Bank, South Sea, and India Houses.

	£.	*Interest.*
Bank Stock -	11,686,800	818,076
5 per Cent. Navy Ann.	21,682,341	1,084,147
4 per Cent. Consol.	41,500,000	1,660,000
3 per Cent. Consol.	142,649,696	4,279,490
3 per Cent. Reduced	41,540,073	1,246,292
3 per Cent. 1726 -	1,000,000	30,000
Long Annuities -	-	853,018
Sh. Ann. 1778, 1779	- -	418,333
3 per Cent. Imp. Ann.	3,833,333	115,000
Ditto 25 years from 1794	-	230,000
Exchequer Ann. -	-	80,000
Life and Tontine ditto	- -	110,000
South Sea Stock -	3662,784	128,197
3 per Cent. Old S. S. Ann.	11,907,470	357,224
3 per Cent. New S. S. Ann.	8,494,830	254,844
3 per Cent. 1751 -	1,919,600	57,588
India Stock -	6,000,000	630,000
	£. 295,876,929	12,352,503

The Long Annuities were granted for 99 years from 1761. Short Annuities, 1788, for 30 years.

Short Annuities for 1779, for 29 years.

Dividend on Bank Stock, 7 per cent. On South Sea Stock, $3\frac{1}{2}$ per cent. per ann. On India ditto, $10\frac{1}{2}$ per cent. per annum.

Interest on India Bonds 5*l.* per cent. per ann. On Exchequer Bills 4*l.* 11*s.* 3*d.* per cent. per ann.

On Navy Bills of six months date, 4*l.* 0*s.* 0*d.* per cent. per ann.

The interest on India Bonds is due March 31st and September 30th; and the interest on Exchequer and Navy Bills is payable with the principal.

	£.	*Interest.*
The Funded Debt on the 1st. of January, 1796, amounted to	337,022,887	11,857,286
The Unfunded Debt, and its interest, at 5 per cent.	16,000,000	800,000
The Emperor's Loan, consisting of stock in the 3 per cent.	3,833,333	132,000
Ditto Annuity of 230,000*l.* for 25 years from 1794 -	3,371,800	231,507
Total of the National Debt, and its annual expence	£. 360,228,020	13,020,993

By the seven years war, which begun in 1755, and ended in 1762, the public debts were increased above seventy-one millions. By the American war, which began in 1775, and ended in 1783, they were increased above one hundred and twenty millions; and by the present war, which began in 1793, they have already increased above one hundred millions; so that the interest and management of the debt, the money appropriated for the sinking fund, together with the civil list, and other expences of government, were peace concluded immediately, would require taxes to be raised, annually, to the amount of twenty-two millions. (Morgan.)

Bank consols. 3	S. Sea stock. 3½	Bank cons. 4	Bank cons. 5	Bank stock. 7	India stock. 10½	Years purchase of land.	Annual interest.
3 per cents. at 60 are equal	to 3½ at 70	80	100	140	210	20	£. s. d. 5 0 0
61½	71¾	82	102½	143½	215¼	20½	4 17 6
63	73½	84	105	147	220½	21	4 15 2
64½	75¼	86	107½	150½	225¾	21½	4 13 0
66	77	88	110	154	231	22	4 10 10
67½	78¾	90	112½	157½	236¼	22½	4 8 10
69	80½	92	115	161	241½	23	4 6 11
70½	82¼	94	117½	164½	246¾	23½	4 5 1
72	84	96	120	168	252	24	4 3 4
73½	85¾	98	122½	171½	257¼	24½	4 1 7
75	87½	100	125	175	262½	25	4 0 0
76½	89¼	102	127½	178½	267¾	25½	3 18 5
78	91	104	130	182	273	26	3 16 11
79½	92¾	106	132½	185½	278¼	26½	3 15 5
81	94½	108	135	189	283½	27	3 14 0
82½	96¼	110	1372	192½	288¾	27½	3 12 8
84	98	112	140	196	294	28	3 11 4
85½	99¾	114	142½	199½	299¼	28½	3 10 2
87	101½	116	145	203	304½	29	3 9 0
88½	103¼	118	147½	206½	309¾	29½	3 7 9
90	105	120	150	210	315	30	3 6 8

⅛ = 2s. 6d. ¼ = 5s. ⅜ = 7s. 6d. ½ = 10s. ⅝ = 12s. 6d.
¾ = 15s. ⅞ = 17s. 6d.

Suppose, in the newspapers of the day, 3 per cent. annuities to sell for $67\frac{1}{2}$, and bank stock for 173, to know which of these will bring in most annual interest, and what interest will each of them produce; in the first column of the foregoing table you will find, that 3 per cents. purchased at $67\frac{1}{2}$, produce 4*l.* 8*s.* 10*d.* per annum; and in the fifth column, bank stock, which pays 7 per cent. is worth $157\frac{1}{2}$, consequently the price of that stock, in the papers, is 15*l.* 10*s.* too dear in proportion.

Rules for casting up odd Quantities of Stock at the current Price per Cent.

If the quantity of stock you want to know the value of, is larger or smaller than the current price of one hundred, multiply that quantity by the price of one hundred, and from the product strike off the two last figures to the right, as remainders to be further reduced. Example first: what must be given for 126*l.* in the three per cent. annuities at 76, that is to say, when 76*l.* will buy 100*l.*? and, second, what must be received for 47*l.* three per cent. annuities, when the price is 76*l.* per cent.?

1st. Ex. $126l. \times 76 = 97{,}76 = 95l.\ 15s.\ 2\frac{1}{4}d.$

2d. Ex. $47l. \times 76 = 35{,}72 = 35l.\ 14s.\ 4d.$

If the price happens to be $\frac{1}{8}$, $\frac{3}{8}$, $\frac{5}{8}$, or $\frac{7}{8}$, in the case where your quantity is larger than the price per cent. (or even when the sum is smaller than the price per cent. if it consist of two figures,) take the $\frac{1}{8}$, $\frac{3}{8}$, $\frac{5}{8}$, or $\frac{7}{8}$, part of the large sum, (or the small one, consisting of two figures,) and throw it in after the multiplication. For example, what must I receive for 146*l.* three per cent. annuities, when the price is $76\frac{5}{8}l.$?

$146 \times 76 = 11096$. $\frac{1}{2}$ of $146 = 73$. $\frac{1}{8}$ of do. $= 18l.\ 5s.$ together $= 111{,}87 : 5 = 111l.\ 17s.\ 5\frac{1}{4}d.$

If the quantity of stock consist only of one figure, then the shortest way is to multiply that by the price per cent. and to take in the fraction, in one line. Example, what is the worth of 9*l.* at $76\frac{5}{8}l.$ per cent.?

$76l.\ 12s.\ 6d. \times 9 = 6{,}89 : 12 : 6 = 6l.\ 17s.\ 11d.$

One hundred grains of each of the three mineral acids, take up at the point of saturation of each metallic substance, oxygenated to such a degree as is necessary for its solution in each acid, the quantities expressed in the following table, which denote their degree of affinity to each metal. (Kirwan.)

TABLE of the Affinity of the three Mineral Acids to Metallic Substances.

100 Grains.	Iron.	Copper	Tin.	Lead.	Silver.	Mercury.	Zinc.	Bismuth.	Nickell	Cobalt.	Antimony.	Arsenic
Vitriolic Acid	270	260	138	412	390	432	318	250 310	320	360	200	260
Nitrous Acid	255	255	120	365	375	416	304	290	300	350	194	220
Marine Acid	265	265	130	400	420	438	312	250 320	275 310	370	198	290

Quantity of Basis taken up by 100 Grains of each of the Mineral Acids. (Kirwan.)

	Potash.	Soda.	Calcareous earth.	Ammoniac.	Magnesia	Argill.
Vitriolic Acid	215	165	110	90	80	75
Nitrous Acid	215	165	96	87	75	65
Marine Acid	215	158	89	79	71	55

Thus 100 grains of each of the acids require, for their saturation, a greater quantity of potash than of calcareous earths, more of this earth than of ammoniac, more of ammoniac than of magnesia, and more of magnesia than of earth of allum.

TABLE of Affinities, by Mr. de Morveau.

	Vitriolic Acid.	Nitrous Acid.	Muriatic Acid.	Acetous Acid.	Carbonic Acid.
Barytes	66	62	36	28	14
Potash	62	58	32	26	9
Soda	58	50	31	25	8
Lime	54	44	24	19	12
Ammoniac	46	38	21	20	4
Magnesia	56	40	22	17	6
Argill	40	36	18	15	2

The Affinities of three Mineral Acids to the several Calces, and the Affinities of the Calces to the different Part of their Phlogiston. (Kirwan.)

	Iron	Copper.	Tin.	Lead	Silver	Mercury.	Zinc	Bismuth	Cobalt.	Nickell.	Antimony	Arsenic.	Manganese	Wolfran.
Vitriolic Acid	270	260	138	412	390	432	318	$\frac{250}{310}$	360	320	200	260	200	260
Calx to Phlogiston	250	360	218	483	491	532	298	350	300	338	300	320	300	320
Nitrous Acid	255	253	120	363	375	416	304	290	350	300	194	255	194	255
Calx to Phlogiston	250	363	218	424	494	552	337	400	383	338	308	366	308	366
Marine Acid	265	265	130	400	420	438	312	$\frac{250}{320}$	370	$\frac{275}{310}$	198	290	198	290
Calx to Phlogiston	165	260	404	290	491	500	200	280	360	265	240	300	260	300

Thus if a piece of copper be put into a saturate solution of silver in nitrous acid, the silver will be precipitated, for the balance is in favour of the divellent affinities.

Quiescent Affinities.		*Divellent Affinities.*	
Nitrous acid to silver -	375	Nitrous acid to copper -	255
Calx of copper to phlogiston	363	Calx of silver to phlogiston	491
Sum of the quiescent affinities -	738	Sum of the divellent affinities	746

ERRATA.

Page 1. line 17. for " abitrary," read " arbitrary."
Page 5. l. 8. from the bottom, for " 1795," read " 1796;" and for " 1796," read 1795."
Page 7. l. 13. Sund. 2. 9. 16. 23. for " 29," read " 30."
Page 16. l. 3. from the bottom, for $\frac{q-n\times 4}{4}$ read $\frac{q-n+4}{4}$
Page 17. l. 3. from the bottom, for " $n\times 1$," read " $n+1$;" and correct the next sentence as follows: " Suppose $m=7$ and $n=4$, the changes taken n at a time, will be $7\times 6\times 5\times 4=V$; taken $n+1$ at a time, will be $7\times 6\times 5\times 4\times 3=V\times \overline{m-n}$."
Page 18. l. 15. for $\frac{1\times 2\times 3\times 4\times 5\times 6}{1\times 2\times 3\times 2\times 3}=60$, read $\frac{1\times 2\times 3\times 4\times 5\times 6}{1\times 2\times 1\times 2\times 3}=60$.
Page 19. l. 7. read " which series *is*, &c."
Page 24. l. 18. for " 240," read " 256."
Page 20. l. 23. for " S. Dalby," read " I. Dalby."
Page 28. l. 4. for " Mr. J. Dalby," read " Mr. Isaac Dalby."
Page 33. table, for " Wickell," read " Nickell."
Page 43. l. 10. from the bottom, under *copper*, for " 253," read " 255."
——— line *penult*. for " 491," read " 494."
——— last line, for " 746," read " 749."